
Social and perceptual processes in the installation *The Trade*

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Through a discussion of the installation piece, *The Trade / Oro por Baratijas*, we address the theoretical issues behind the development of ecologically based compositional work. We discuss whether ecologically based music can be studied using linguistic tools. The concepts of potentiality and actuality are situated within the perspective of individual–environment interactions. A process that describes the relationship between an individual and his specific social context is proposed: the personal environment. Consistency is discussed in relation to environmental sound listening processes and ecological modelling work. The first part of the paper concludes by suggesting that form-creation is dynamically determined by a process of mutual adaptation between listener and environment. The second part focuses on compositional methods and contextual elements as they are used in *The Trade*. This work has been developed through a multilevel approach where visual and sonic materials stem from social and historical issues. The organisational processes of the sound piece are based on the micro-temporal and spectral properties suggested by the visual elements in the installation. The meso-temporal dynamic is organised through ecologically constrained events. The macro-structural shape and the sources used in the piece make reference to a specific historical context, i.e. the conquest of the American continent by the European armies during the first half of the sixteenth century.

1. INTRODUCTION

Ecologically based compositional processes make use of sound classes and temporal groupings to provide cues familiar from the listener's everyday sonic experience. Social references situate the work in a cultural context. These compositional strategies do not fit within traditional theoretical categories: concepts that stem from pitch-based and tonal music do not apply to dynamical processes that are context dependent and listener specific. Abstract and universal laws lose meaning when they are applied to music linked to a specific sociocultural environment. Thus, a theoretical approach that works from the level of sonic elements up to the level of sociocultural relationships is needed in order to develop ecologically based sound works.

The first two sections of the paper address two aspects

of the theoretical work in ecologically based composition which resonate with more general issues in music perception and theory. First, we discuss the perceptual processes involved in environmental sound and music listening. Experimental evidence is presented to support the view that music auditory processing does not necessarily make use of syntax-based or language-mediated mechanisms. Then, we study the relationship between musical processes and social dynamics from the perspective proposed by Shepherd's (1992) article. This perspective is taken a step further by integrating both the natural and cultural context within the musical and environmental sonic organisations into a single dynamic process.

The next two sections examine more closely specific conceptual problems raised by ecologically based research. Structural coupling is proposed as a way to establish dynamic relationships between the individual and the environment which in turn render potential and actual meanings. Within the context of ecologically based sound synthesis and composition, consistency among auditory cues is a basic requirement for establishing sound model constraints. The salient characteristics of everyday sounds are summarised and the section concludes with a succinct review of the main theoretical items presented.

The second part of the paper is devoted entirely to the discussion of the installation piece *The Trade*. A brief description of the visual components of the piece is followed by an explanation of the historical underpinnings of the work. This section of the text includes direct citations of Spanish soldiers involved in the conquest of America. The next three sections address the compositional techniques and the symbolic interlocking of the visual and sonic elements in the piece. The visual material, i.e. the gilded chest and corn grains, the historical context, the spoken text, and even the installation space are all integrated into the sound synthesis and organisational strategies utilised in the soundtrack.

1.1. Music as cultural . . . text?

Shepherd (1992) differentiates between two perspectives in musicological and theoretical music research by their

object of study: (i) cultural context, the social circumstances surrounding the creation and appreciation of music, and (ii) cultural text, the sounds of music as carriers of social and cultural messages. The focus of this section will be the cultural text, specifically the theoretical shortcomings of syntax-based or linguistically oriented analytical and compositional approaches.

By introducing the actual sounds as a valid object of research, Shepherd's work departs from traditional musicological methods that deal with everything but the actual music (cf. Leppert and McClary 1987). In spite of his more open approach to music, Shepherd's use of the word 'text' to identify musical phenomena brings up some problematic conceptual issues. 'Text' as a description of musical sound carries the implication that music is equivalent to written language. Therefore, it can be analysed with the same tools: linguistic, semiological or syntactical (Lerdahl and Jackendoff 1983). Syntax-based analysis is based upon the premise that music is shaped by abstract relationships which are not necessarily dependent on the dynamics of sonic processes. It comes as no surprise that compositional strategies concerned with spectro-temporal patterns are difficult to explain with these tools.

Although Shepherd acknowledges the existence of musical sounds that do not lend themselves to syntax-based analysis, he nonetheless distinguishes between sound structure and structured sound, holding the latter to be the generative source of meaning in music. According to Shepherd (1992: 136), meaning is conveyed by musical syntax: 'the abstract relationships between sonic events'. Similarly to Boulez (1992) and other music theorists, he asserts that these relationships have existence 'primarily through the parameter of pitch, and to a lesser extent, through the parameter of duration (. . .)'. As we have discussed and showed experimentally, musical parameters interact (Tróccoli and Keller 1996). The listener's musical experience is not defined by orthogonal, out-of-time variables, such as pitch represented on a staff, but by the interaction of concurrent processes that unfold in time during actual listening (Melara and Marks 1990). These processes do not occur solely at the level of syntactical events (musical notes), they also take place at the micro (timbral) and at the macro level (musical morphology). In other words, analysing music syntax using out-of-time notation creates an object of study that does not correspond to any actual musical experience.

Further support for the idea that music listening processes are not syntactically based comes from studies in sound identification and linguistic labelling. The experimental hypothesis runs as follows. If sounds are organised using linguistic mechanisms, a two-stage process is necessary: before cognitive relationships among stimuli are established, linguistic labels need to be assigned to each of them. Therefore, experiments have

to test whether identification processes, such as labelling, take place in music listening. As a complementary test, the difference between identification and recognition mechanisms needs to be clearly established.

Handel (1995) brings up a paradoxical study by Eustache, Lechevalier, Viader and Lambert where a subject with a 'left temporoparietal lesion was unable to identify common tunes but was able to discriminate whether two tunes were the same in terms of one false note, rhythm, or tempo. (. . .) [In contrast], another subject with a right frontal lesion could identify environmental sounds and familiar tunes, but was unable to say whether two sounds or tunes were the same.' These results indicate that performance in identification tasks is not directly related to performance in discrimination tasks. Therefore, the labelling and speech-based cognitive mechanisms used in identification might not be engaged in the comparison of auditory stimuli.

To study whether labelling mechanisms were used in the organisation of acoustic stimuli, Warren (1993: 40) employed a task of ordering acoustic sequences. The stimuli consisted of groups of sounds played as a loop. When subjects had to identify the order of the sounds presented, the reaction times were between 100 and 200 ms. On the other hand, when subjects were asked to discriminate between different orderings of sounds, minimum thresholds dropped to 5 to 10 ms. Warren argues that at fast rates, subjects rely on holistic strategies to order the sounds. His article outlines two possible mechanisms for the recognition of acoustic sequences: (i) holistic pattern recognition, where 'temporal compounds' are not resolved into an ordered sequence of elements, and (ii) identification of components, which involves the application of linguistic skills in labelling the items. These results suggest that the micro-temporal sound structure – within the range of a few ms – which characterises environmental sounds, is usually processed by prelinguistic mechanisms. Warren (1993: 62) also summarises several studies which show that other mammals also use holistic mechanisms to group sounds. He hypothesises that our 'use of speech and production and enjoyment of music might be based upon an elaboration of global organisational skills possessed by our prelinguistic ancestors'. In other words, music listening is probably based on spectro-temporal cues and does not necessarily rely on linguistic constructs (figure 1).

Handel (1995: 456) states that 'there is rather strong evidence that the processing of speech and music is done in different parts of the cortex'. He points to examples in the literature which show that individuals suffering from auditory agnosia can neither recognise nor identify a sound, even though they can perceive changes in its acoustical properties, i.e. frequency and amplitude. Other subjects are able to understand complex verbal material but fail to identify environmental events. Furthermore, some patients are unable to discriminate

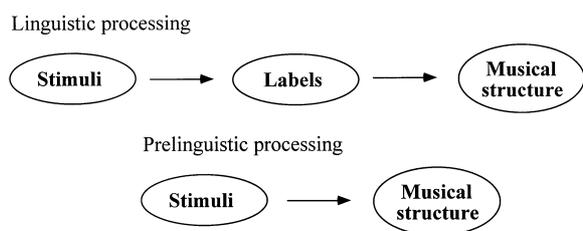


Figure 1. Prelinguistic mechanisms in music listening processes.

voices but recognise environmental sounds (Handel 1995: 457 and references therein).

If compositional strategies are to be perceptually grounded, we have to move away from syntax-based methodologies to forms of sonic organisation that deal simultaneously with the micro, the meso and the macro. Because environmental sounds are characterised by highly varying micro- and meso-temporal structures (Keller and Truax 1998, Keller 1999a), syntax-based analysis fails to deal effectively with their underlying organisational processes. Given that most perceptually relevant processes take place at a prelinguistic level, linguistic approaches are inappropriate to understanding their dynamics or to transforming them compositionally. An alternative approach is to employ compositional models based on the sonic and referential material used in the piece. This is the perspective adopted by soundscape (Truax 1996) and ecologically based composition (Keller 1999b).

The next section will discuss the interactions between social context and musical structure while placing the processes of form-creation within the realm of social and perceptual dynamics. The three existing currents of thought can be described as: (i) autonomy, (ii) structural homology, and (iii) relative autonomy. The section concludes by proposing a concept that brings together the interaction between the social context through the individual's cultural baggage, and the sonic environment including the musical processes: the personal environment.

1.2. Pure music

Although Shepherd (1992) supports the view that compositional processes should make use of extra-musical references, his concepts are not entirely consistent with an environment-based approach. '[Unlike] the sounds of language, sounds in music never refer directly to people, events and objects in the external world. They either copy or evoke symbolically the sonic manifestations of those people, events and objects. Secondly, sounds in music seem not to function in a fundamentally arbitrary fashion. They function in a structural fashion that allows them to evoke, directly and powerfully, the logics and structures of the socially mediated inner life.' (Shepherd

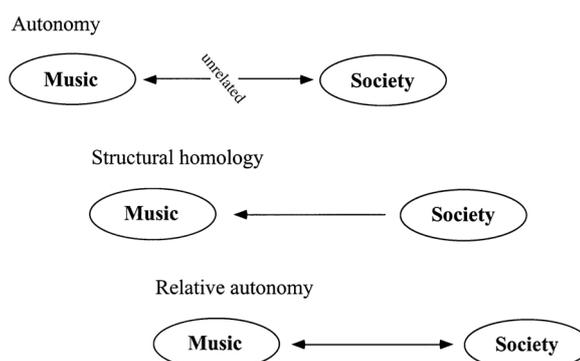


Figure 2. Forms of interactions among social and musical structures.

1992: 142) Shepherd is referring to syntactical structure and not to the spectro-temporal dynamics of sound. The distinction between direct reference, as given by environmental sounds, and indirect reference, provided by what he calls musical sounds, is particularly illuminating. It clearly reflects the view held by most music and cultural theorists regarding what sound elements are 'musical'.

Regarding music's cultural context, Shepherd (1992) identifies three main analytical perspectives: (i) autonomy, (ii) structural homology, and (iii) relative autonomy. The focus of each of these approaches can easily be represented in terms of how social structure influences musical structure and vice versa (see figure 2).

Most European and North American (ENA) music theorists believe that musical structure and meaning bear no direct connection to the social context in which music is created. When analysing stylistic features of a specific musical period, e.g. sonata form in Classicism, changes in compositional techniques are usually explained by purely structural criteria and are seldom assigned to extra-musical causes (Bent 1987, Boulez 1992). This attitude is not confined to music theory but also permeates other music research areas (cf. Sloboda 1985, Parncutt 1989, Krumhansl 1990). Within the field of music psychology, McAdams (1987: 13) maintains that music is an autonomous phenomenon. 'Music creates a non-referential (or perhaps a self-referential) world. (...) It does so through psychological dimensions that are unique to music.' Furthermore, he criticises the use of referential elements in music because they hinder the structural coherence. 'One of the problems with musique concrète is that the sound elements (...) have such strong references to everyday life that they are made to cohere with an overriding structure only with great difficulty. (...) In a sense, the material is not only too identifiable but is also too discontinuous or categorised to be assimilable into a form that is foreign to its already strong semantic function.' (McAdams 1987: 55) Although his assessment of concrete music may be correct, by now it is clear that its structural weaknesses

are not caused by the elements themselves but by the transformations (or lack thereof) imposed onto the material (cf. Schaeffer 1993, Palombini 1998). The compositional gap to be filled lies in the development of transformational techniques that do not destroy the referential elements of the recorded sound material. Furthermore, this technical insufficiency points to a conceptual shift from sound organisations established by formal processes to sound organisations framed by environmental constraints. This is precisely the approach taken in ecologically based composition.

At the other end of the conceptual spectrum, structural homology provides an alternative to analytical practices that are ungrounded in social content. Arnold Hauser (1951) maintains that the notion of autonomous art is inextricably linked to capitalist socioeconomic structures. The conception of an independent artist, as opposed to a craftsperson, depends on the dissolution of the direct bond between artist and patron. This bond is replaced by a dependency on dealers, critics, art institutions, etc., which act as mediators between art producers and the consumer market. In other words, music reproduces the structure of the society in which it is being produced. Therefore, musical meaning is directly related to the social structure that supports it.

Shepherd's (1992: 137) notion of relative autonomy establishes a compromise between autonomy and structural homology. His approach strikes a balance between social determinism and musical independence from social dynamics. '(...) The significance of musical sociality does not necessarily originate outside "musical processes"'. However, musical sociality would be of little significance if its internal logics and structures were of no relevance to the logics and structures of other, non-musical social processes. (...) No artistic or cultural forms need depend on non-artistic or non-cultural social processes for their significance. (...) An "autonomous" musical sociality (that is, "autonomous" musical processes as social processes) may be thought of as resonating, either harmoniously or dissonantly, with other areas of non-musical sociality.' In other words, music gives life to the conflicts taking place in society, but does not literally follow the dynamics of social interactions.

Although we do not agree with Shepherd's use of relative autonomy in support of the mythic 'expression' (Stambaugh 1989: 143), 'creativity' and 'individuality' of the composer, we believe that his position raises interesting theoretical implications. Since '[music] offers up *potentials* and *possibilities* for the construction and investment of meaning on the part of people' [his italics], these possibilities can only be realised in the act of listening. And, listening implies enacting the social and cultural processes ingrained in the piece of music and in the listener's sonic experience (North and Hargreaves 1997). Concerning *The Trade*, the conceptual interpretation of the work is directly related to the geographical and cultural context from which the piece is

apprehended. The conflict between the dominant and the subjugated culture resonates with the current situation of several Latin American societies.

Ecological psychology researchers such as Michaels and Carello (1981: 44) have drawn a line between the cultural and the 'natural' environment. Nevertheless, if we abide by the idea that the musical environment is listener specific, then a single concept can encompass the multiplicity of contexts brought into play when listening to music: namely, a 'personal environment'. This environment places the work within the listener's cultural context and re-enacts his previous sonic experiences. Thus, instead of forcing sound and its organisation into abstract 'universal' moulds, we can use the listener's specific background to interpret and develop a work from an individual cultural and natural context.

Viewed in this light, there is no culturally neutral listening experience. Every music carries the cultural baggage of its social origin and every listener places the music within his personal environment. The clash between these two contexts informs the creation of musical meanings and simultaneously reshapes the personal environment. Thus, an ever-changing history of meanings is established.

1.3. Structural coupling

Shepherd's division between potential meanings offered by the sound structure and the actual meanings realised through the act of listening finds an interesting parallel in the notion of 'evolution by drift' put forth by Varela, Thompson and Rosch (1989). The theoretical biologist Francisco Varela suggests that animal and environment are mutually determined. Evolution and cognition are shaped by long-term interactions between individual and environment. Contrasting with the cognitive approach, 'cognition is no longer seen as problem solving on the basis of representations; instead, cognition in its most encompassing sense consists in the enactment or bringing forth of a world by a viable history of structural coupling' (Varela *et al.* 1989: 205). As the Spanish poet Antonio Machado said, 'se hace camino al andar'.

The key idea differentiating the approach of Varela *et al.* (1989: 196) from neo-Darwinian adaptationism is the shift from optimal adaptation to 'satisficing' fitness. This means that adaptation mechanisms may not be optimal; they just need to fulfil survival requirements. Varela *et al.* (1989: 194) states that '[the] constraints of survival and reproduction are far too weak to provide an account of how structures develop and change. Accordingly, no optimal fitness scheme apparently suffices to explain evolutionary processes.' Patterns of animal communication exemplify a case of varied solutions to the same problem. The use of selective frequency ranges, distinctive time-patterns, or even fast-varying timbral changes are alternative approaches to sound streaming in a noisy

environment. A particularly problematic issue is the distinctiveness of signals among bird species that compete for the same niche within a common sound environment. Time-sharing between and within species is one of the strategies employed to reduce the temporal overlap among signal emissions (Nelson and Marler 1990). Another example of selective adaptation to environmental characteristics is ‘the high-pitched, narrow-band, whistled alarm calls used by animals in extreme danger (. . .). Due to attenuation, the high frequency signal is limited to a small surrounding space. This signal might be audible to companions close by, but will probably not be heard by the predator.’ (Nelson and Marler 1990: 444)

A complementary aspect of evolution by drift is the mutual determination between the individual and its environment, i.e. structural coupling. ‘[Living] beings and their environments stand in relation to each other through mutual specification or codetermination. (. . .) Environmental regularities are not external features that have been internalised, as representationism and adaptationism both assume. Environmental regularities are the result of a conjoint history, a congruence that unfolds from a long history of codetermination. (. . .) The organism is both the subject and the object of evolution.’ (Varela *et al.* 1989: 198) Again, a specific example of transmission of information in ambient acoustics is provided by Nelson and Marler (1990: 445): ‘Far from being a random phenomenon, the background against which animal signals must be detected and discriminated is often highly structured. It may even interact with the behaviour of the signaller. (. . .) Thus the sound environment in which an animal species has evolved has a strong influence in shaping the acoustic signals employed for purposes of social communication.’

The separation between environment and individual in the formation of cognitive structures is arguably a severe limitation in cognitive approaches. ‘[Perception] consists in perceptually guided action and cognitive structures emerge from the recurrent sensorimotor patterns that enable action to be perceptually guided. (. . .) Cognition is not representation but embodied action. (. . .) The world that we cognise is not pregiven but enacted through our history of structural coupling.’ (Varela *et al.* 1989: 200) Thus, it is not a mental representation that establishes the formation of perceptual processes but the bodily interaction between the environment and the individual. A good example in the musical realm is Smalley’s (1993) assertion that instrumental gesture is a refinement of our daily interaction with objects in the environment. ‘The passage from object experimentation to the creation of a musical instrument involves the increasing refinement of hitting, scraping, or blowing (. . .).’ (Smalley 1993: 537)

The next logical step that the enactive perspective brings forth is to ‘recast selective pressures as broad constraints to be satisfied’ (Varela *et al.* 1989: 198), thus

Formal system vs. ecologically-informed system

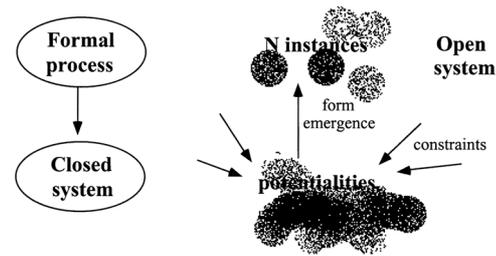


Figure 3. Comparison between formal closed systems and structural coupling as a pattern-formation process.

allowing for the occurrence of patterns that are not necessarily determined by selection. A metaphor for this conception is ‘evolution as bricolage, the putting together of parts and items in complicated arrays, not because they fulfil some ideal design but simply because they are possible’ (Varela *et al.* 1989: 196). More specifically, ‘form emerges in successive interaction. Far from being imposed on matter by some agent, it is a function of the reactivity of matter at many hierarchical levels, and of the responsiveness of those interactions to each other. (. . .) [The] extra-organismal environment is made internal by psychological or biochemical assimilation. [An] internal state is externalised through products and behaviours that select and organise the surrounding world.’ (Oyama 1985, cited in Varela *et al.* 1989: 199) The hierarchy principle cannot be applied to the organisation of sound (Keller and Silva 1995). Nevertheless, this thesis is consistent with an ecologically based theoretical framework in relation to the idea that musical structures provide potential meanings which are realised through a mutual determination process between individual and environment (figure 3).

1.4. Consistency: relaxing optimality

As we have seen in the previous section, current evolutionary theories view natural selection as the realisation of possible outcomes rather than as a result of necessity. In other words, we ‘recast selective pressures as broad constraints to be satisfied’ (Varela *et al.* 1989: 198). This perspective allows for the occurrence of patterns that are not necessarily determined by selection. In contrast, the traditional artificial intelligence approach is to come up with a single, optimal solution within a predefined parameter space.

The adaptability of auditory mechanisms places two requirements on how perceptual and compositional models can be implemented: (i) the same mechanisms may be used for different stimuli in different contexts, and (ii) several perceptual states can be obtained from a single stimulus. The first requirement can be deduced from the precedence effect: regardless of the source sound, the perceptual system separates the source from

the ambient reflections. The second requirement can be exemplified by the repeating stimuli used by Warren (1993). These stimuli are perceived as changing even when no physical change occurs. In his 1993 study, Cooke came to a similar conclusion: ‘(. . .) the questions of optimality and search are not often raised in experimental studies of auditory grouping. Instead descriptions of strategies are more common. (. . .) [This] work is based on heuristics which express the belief that it is possible to discover similar groupings from large numbers of different starting points.’ (Cooke 1993: 55)

Based on Bregman’s (1990) experimental findings, Ellis (1996: 54) proposes more flexible criteria for a better match between models and data in auditory processing. A data-driven model, such as Cooke’s, constructs successive levels of abstraction founded on the identifiable features of the data. On the other hand, ‘in the prediction-driven framework, the model itself is obtained by drawing predictions from the existing components, and the “connection” is limited to ensuring that the model falls somewhere in the space of uncertainty. Depending on how model and stimulus uncertainty are represented, there may be a wide range of possible matches, with a continuum of resulting confidence or quality metrics, rather than a single, brittle yes/no comparison.’

Thus, the work done in computational auditory modelling converges with the theoretical approach proposed in evolutionary biology: perceptual mechanisms are constrained by environmental requirements but no single optimal solution exists for a given state in the process of individual–environment interaction.

1.5. Ecological models

Translating the principles discussed in the previous section to the compositional domain requires the implementation of sound models that provide environmentally consistent sonic cues. Consistency in this context can be defined as the relationship among the dynamically varying sonic cues, which abide by the characteristics of the environment and the source–object states. These constraints provide a basic framework for the development of ecological models, moulded after the properties of everyday sounds. Among the most relevant properties we can list: (i) the minimum temporal unit is the ecologically meaningful sound event, (ii) no event happens the same way twice, i.e. spectral and temporal characteristics are always changing, and (iii) the relationship object/event is constrained by the object’s affordances, i.e. a given object can only produce a limited range of spectro-temporal behaviours.

By following the previously stated premises, we ensure that the output of the synthesis model remains within the given sound class while avoiding a one-to-one correspondence between the model and the sounds obtained. In other words, as long as the sound model

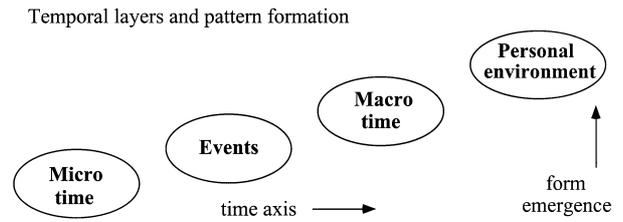


Figure 4. The multiple temporal layers and their relationship with the personal environment.

parameters are kept within ecologically valid ranges, each instance of the model will belong to the given sound class but no two instances will be exactly the same. In *The Trade*, meso-time variables are directly related to environmentally feasible actions such as pouring or throwing. Micro-time sonic configurations correspond to the excitation of resonant bodies, in this case metallic objects and small, enclosed spaces.

1.6. Summary of the theoretical considerations

The previous discussion suggests that ecologically based musical approaches need to be grounded on the specific social environment where the musical work is placed, taking into account the dynamics of sound structures and the listening processes involved. The separation between musical sound and environmental sound can only be made in relation to a specific artwork within a given cultural context. It makes no sense as a general or *a priori* statement. Truax (1996) has argued that the ability to establish direct references to the environment make mundane sounds the ideal material for music composition. These sounds provide a way to create meaningful symbolic systems by arousing associations with the listener’s sonic experience. A new layer of meanings is thus established where the listener’s cultural context can interact with the dynamics of sonic structures. We have grouped these mechanisms under the concept of ‘personal environment’.

Compositional tools that are fit to work with everyday sounds need to be developed around these axes: ecologically meaningful events, sound classes and sound behaviours consistent with the objects’ affordances. As has already been stated, sounds produced by means of ecologically based models provide cues of environmentally feasible events. Thus, they render stimuli which are coherent with pattern-formation processes (figure 4). If mutual-determination is a reasonable model, we should expect to find perceptual mechanisms that are fine-tuned to process frequently occurring environmental sounds.

To fully embrace the codetermination approach means to accept the idea that music is realised at the moment of listening. This perspective places the concepts of potentiality and actuality in musical meaning within a process of constant interaction and transformation

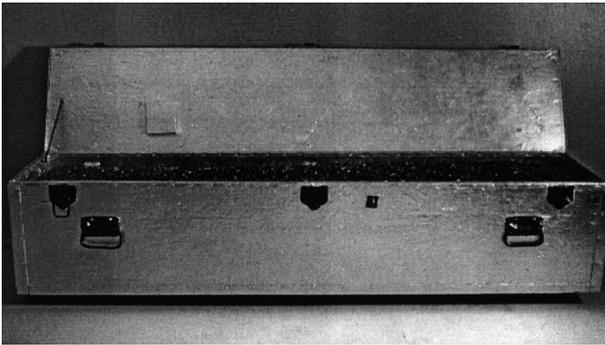


Figure 5. Visual elements of *The Trade/Oro por Baratijs*.

between the individual and the environment. Accordingly, the individual's specific sonic experiences and the music's spectro-temporal patterns establish an always-renewed set of form-creation processes that bring forth an ever-changing history of meanings.

2. THE TRADE

In this section we will provide a specific example of an ecologically based piece: *The Trade*. After a short description of the visual elements used in this installation, we will lay out the historical background of the piece's theme: the conquest of the American continent by the Europeans. The title refers to the multicultural exchange between aboriginals and Europeans that took place during the 1500s. Several connotations of the word 'trade' are explored in the sound piece. The installation space is further integrated into the compositional process by means of sonic synthesis, transformation, and placement of the sound sources.

The Trade, or *Oro por Baratijs* in Spanish (literally, 'Gold for Trinkets'), was exhibited at the Second Annual Art Show of Boulder during February 2000. It was also presented from 7 to 22 July 2000 in the exhibition, 'Buy a Piece of America – Opiniones Encontradas', at the Chicano Humanities and Arts Center in Denver, Colorado. The installation consisted of a gilded chest containing corn kernels which was placed at a corner of a dark room (figure 5). A single light was focused on the chest. The ten-minute soundtrack, recorded on CD, was played continuously (loop mode). Sound came out of two speakers positioned under the corn grains. The sound became audible within a distance of one and a half to two metres from the box.

2.1. The conquest: historical perspective

The conquest of the American continent, or the 'Indias' as the Spanish used to call it, was probably the greatest genocide in human history. In less than fifty years, the conquerors not only decimated the indigenous population but also managed to destroy the social structure of millenary civilisations (Las Casas 1949, 1995). Besides

bringing illness and misery to the American nations, they also imposed a system of beliefs that went directly against the aboriginals' world views.

Though the driving force of the conquest was the search for gold, its fuel was the available food. The *modus operandi* of the European *conquistadores* was to take control of a town either by diplomacy or by force. Once the Indians were subjugated, the town resources were exploited to exhaustion. Then, a new expedition would be sent to conquer another city. No lasting expedition was possible without the consumption of food reserves which had been obtained through the agriculture and hunting done by the local population.

The new continent provided nourishment for a starving army. Potato, cocoa and corn had been traditionally used by the indigenous people. The Spanish soldiers had no tools or intention to seed the land. Therefore, they had to rely on the local agriculture and fauna as the only source of food. The unrestricted extraction of resources coupled with the disintegration of their social organisation precipitated a breakdown of the previously existing social balance. Within a few years, most aboriginal towns were devastated by poverty and lack of sustainable production. Bernal Díaz del Castillo, a Spanish soldier who entered Mexico City with Hernán Cortés, describes in great detail the marvellous richness of the city and compares this to its later condition (in the decade between 1572 and 1582). 'Y desde que entramos en aquella ciudad de Estapalapa, de la manera de los palacios donde nos aposentaron, de cuán grandes y bien labrados eran, de cantería muy prima, y la madera de cedros y de otros buenos árboles olorosos, con grandes patios y cuartos, cosas muy de ver, y entoldados con parámetros de algodón. (. . .) Digo otra vez que lo estuve mirando, que creí que en el mundo hubiese otras tierras descubiertas como estas (. . .)' (Castillo 1949: 245–6). He follows with an elaborate description of the superb quality of their living quarters, the aromatic woods, plants and flowers used by the Aztecs, contrasted against the depressing present condition of the city. What used to be a beautiful lake, had been dried out and turned into corn fields: '(. . .) era muy gran pueblo, y que estaba poblada la mitad de las casas en tierra y la otra mitad en el agua, y ahora en esta sazón está todo seco y siembran donde solía ser laguna'.

The context-dependent symbolism of materials such as corn and gold is made painstakingly clear when we examine the clash of paradigms occurring during the occupation of America. Several authors recount the inability of the Indians to comprehend the obsessive drive for gold of the Europeans (Las Casas 1949). It can be deduced from the decimation of lives and cultures that has taken place since the arrival of Europeans in America, that the currently dominant civilisation is reluctant to understand or accept other cosmologies, especially when these views are intimately interwoven with the natural environment. For example, in the case

of Chiapas, this systematic destruction continues to the present day.

2.2. Trading

The action of trading takes on several connotations in relation to the visual and sonic organisation of the piece. From a historical perspective, there is the trade between Indians and Europeans where the former provided food and gold, in return for evangelisation and war. Thus, there was an exchange of both material and cultural goods. Regarding the visual layout of the piece, the gilded chest acts as a container to hold the most important resource for the conquest: food. For the highly developed aboriginal cultures, corn formed the bulk of their diet (De la Vega 1993). Therefore, it could be used as an appropriate symbol for nourishment.

When the installation is experienced by the public, a new form of trade takes place. The light design draws attention solely to the chest. The fact that it is open encourages the viewer to discover its contents. Similarly, the softness of the soundtrack levels forces the listener to get closer to the piece and peek in. In fact, during the first exhibition we found out that many people would touch the corn in order to feel its texture and would grab handfuls to pour back into the chest. The actions suggested by the symbolic elements in the piece were actually brought to life by the spectators!

The organisational processes behind the sound piece are also moulded after the dynamics of trading. There are two basic sound classes in this work: (i) falling grains, which can be perceived as corn grains, gold coins, or water drops, and (ii) voices, which consist of a group of words and short phrases in Spanish extracted from a reading of the short story 'El Regreso' (César 1999), such as 'tierra' (land), 'choclos' (corn) and 'memoria' (memory). Only in the third section are both classes fused (minutes 7:16 to 9:37). To obtain the material for this section, we synthesised a long train of excitation impulses using falling-grain samples. Then, by means of convolution, we created a hybrid between the falling-grains sound and a spoken word. More specifically, the spectral profile of the recorded voice was mapped onto the temporal pattern established by the falling grains.

2.3. Sonic processes

The visual elements in the piece suggested a direct mapping onto sound synthesis and compositional strategies. The action of pouring corn into the box provided the first raw sound source. Concurrently, this action suggested the micro-temporal structure of the piece, i.e. the impacts of corn grains onto different surfaces. It also suggested its meso-temporal organisation, i.e. the action of pouring grains. As Jonathan Harvey put it, this form

of sound synthesis could be called 'medieval granulation'. Regarding the spectral characteristics of the sound material, the treasure chest suggested the use of metallic resonances. These resonances were obtained by feeding the output of ecological models into different types of resonators (Keller 1999a). By varying the parameters of the resonators, the algorithms modified the synthetic sounds in two ways: they created resonances similar to metallic objects being struck, and they produced short reverberations that hinted at small enclosed spaces.

As previously stated, all the voice material was generated from a few voice samples. Several words and short sentences were taken from a reading of a short story by Argentinean writer Nora César. The reading was performed by the writer herself, thus bringing out the subtleties of intonation and pacing that the text requires. Furthermore, it retains the local colour of speech and its typical expressions. Two types of processing were applied on the voice source sounds: time-stretching by means of asynchronous granular synthesis (Keller and Rolfe 1998) and ecologically based techniques (Keller and Truax 1998). The reason for employing ecologically based models was not to approximate existing sounds but to obtain meso-temporal behaviours akin to those found in the complementary sound class being used: falling grains. Simultaneously, the processing applied to the samples provided us with a variety of voices which suggested a multitude of men and women speaking at the same time. A well-known effect used by choral composers is auditory streaming produced by the separation of the spectral content of vowels from the (higher) spectral content of consonants. By controlling the density of vocal events, our algorithmic tools supplied a way to deal with this emergent phenomenon. The second and third sections developed across a continuum, from discrete spoken words to massive fused textures (where consonant articulations are perceptually separated from the vowel-based spectral bands). In this context, the most relevant compositional parameter is density of sonic events and the perceptual effect being controlled is fusion and parsing of spectral and micro-temporal characteristics.

2.4. The time, the place

One effective aspect of *The Trade* is the sensation of imprisonment provoked by some of its visual and sonic elements. Several compositional and visual strategies had to be employed to obtain a consistent spatial and temporal organisation in the piece. The interaction of sound sources and surrounding spaces provided a guiding principle in the conceptual and technical development of the installation. First, the placement of the chest in an empty room furnishes an isolated environment where the spectator is left to dialogue with the symbolic elements of the piece. Second, the location of the sound

sources (inside the chest) is by itself a symbol of imprisonment. At the same time, the overall spectral characteristics of the piece are further affected by the positioning of the two speakers under the corn kernels. Third, the moments when the source is a human voice hint at subjugation and suffering. This feeling is further underlined by the (granular) slowing down applied to the voice which sometimes suggests constrained motion. Finally, the slow pace of the meso-level events also creates a sensation of restricted action and awkward gestural evolution (cf. second section of *The Trade*, minutes 0:56 to 7:35). Interestingly, the first exhibition of *The Trade* was presented at the Conference Center of the Boulderado Hotel in Boulder, Colorado. Thus, the exchange among meanings was not limited to the visual and sonic elements but was further extended by the symbolism embodied in the location of the piece.

The Trade explores three processes that reduce formal movement to a minimum. First, the small number of sonic elements creates stasis at the spectral and micro-temporal level. Most sounds are produced by gesture-constrained stochastic distributions (Rolfe and Keller 2000). Thus, the temporal shape of falling-grain sounds ends up being statistically uniform. No linear development is employed in the piece; each of the three larger sections can be freely interchanged. Furthermore, the distribution of meso-temporal events is sometimes so sparse that each event can be perceived as an independent entity (first section, minutes 0:00 to 0:55). Finally, the formal shape of the piece can be described as a circle: any moment could be interpreted as a beginning. This shape was obtained by keeping consistent micro-level characteristics, establishing no causal relationships among temporally distant events, and giving highly differentiated weight to the macro sections of the piece. Again, the structure of the piece was suggested by the forms of interaction with the public: without hindering the structural balance of the soundtrack, people are brought into the piece whenever they enter the installation space.

3. CONCLUSION

We have described the compositional approach used in the installation piece, *The Trade / Oro por Baratijas*. In order to establish a firm conceptual background for the methodology applied in ecologically based works, we have addressed several theoretical issues which yielded the following conclusions:

- (1) Perceptual processing of environmental sound is not mediated by syntactical and linguistic mechanisms; therefore, compositional and analytical methods need to be grounded on multilevel strategies that take into account micro, meso and macro patterns.
- (2) Musical meaning is dependent upon individual–

environment interactions where sociocultural context and sound structures establish a dynamic process of form-creation; this process is called the personal environment.

- (3) Ecological models have to be shaped after consistent sonic systems. In this context, consistency is defined as the relationship among the dynamically varying sonic cues, which abide by the characteristics of the environment and the source–object states.

Following the above methodological premises, we developed the soundtrack for *The Trade*. As a historical context, we adopted the conquest of the American continent during the sixteenth century. The clash between the aboriginal culture's cosmovisions and those of the invading culture was explored by mapping several forms of 'trading' on to the micro, meso and macro structure of the piece. The spoken text was used as sound source and as a direct reference to the cultural subjugation. The affordances of the visual elements of the installation (the corn grains and the gilded chest) were integrated into spectral and micro-temporal sonic models. The meso-temporal processes were shaped after the gestural actions suggested by these same elements. Also, the macro structure and the distribution of events underlined the sensations of imprisonment and suffering which were purposely framed by the constricted use of the space in the visual part of the installation.

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